The Mystery Cloud of 536 CE in the Mediterranean Sources

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IN 1983 TWO RESEARCHERS at the Goddard Institute for Space Studies, NASA, Richard Stothers and Michael Rampino, published a list of all ancient volcanic eruptions known from Mediterranean historical sources.[1] Their list included a persistent dust veil or dry fog that darkened the sky for about a year in 536–37 CE, bringing about cold, drought, and food shortages in the Mediterranean area or, as it has since been claimed, over all the northern hemisphere. Several ancient writers, such as Cassiodorus, Prokopios, John Lydos, and some Syriac chroniclers, refer to the dark cloud. Somewhat surprisingly, these sources had been overlooked by classical scholars for a long time. The excellent geophysical journal in which Stothers and Rampino's results were published does not seem to have been regularly read by classicists, so it took more than a decade before the event of 536 attracted any significant attention within classical studies.[2]

1 "Volcanic Eruptions in the Mediterranean before AD 630 from Written and Archaeological Sources," *Journal of Geophysical Research* 88 (1983): 6357–71. For their survey, Stothers, an astronomer with a background in the classics, read through all of classical literature. See also R. B. Stothers, "Mystery Cloud of AD 536," *Nature* 307 (26 Jan 1984): 344–45; M. R. Rampino, S. Self, and R. B. Stothers, "Volcanic Winters," *Annual Review of Earth and Planetary Sciences* 16 (1988): 73–99, esp. 87–88.

2 Prokopios's report was already briefly discussed by, e.g., V. Seibel, *Die grosse Pest zur Zeit Justinians I. und die ihr voraus und zur Seite gehenden ungewöhnlichen Natur-Ereignisse: Ein Beitrag zur Geschichte d. 6. Jh. christl. Zeitrechnung*, Programmschrift Dilingen (Dilingen, 1857), 19–20. More than a century later, E. Patlagean, *Pauvreté économique et pauvreté sociale à Byzance, 4e–7e siècles* (Paris, 1977), 76, mentioned the Syriac accounts. After 1983 the articles by these natural scientists were first cited in P. Farquharson, "Byzantium, Planet Earth and the Solar System," in *The Sixth Century: End or Beginning?* ed. P. Allen and E. Jeffreys (Brisbane, 1996), 263–69; J. Koder, "Climatic Change in the Fifth and Sixth Centuries?" in the same volume, 270–85, esp. 276–77. But note, for an earlier event, P. Y. Forsyth, "In the Wake of Etna, 44 BC," *Classical Antiquity* 7 (1988): 49–57.

During the last few years, the event has finally become better known, especially following two popular books devoted to it.[3] The dust veil has been declared the worst climatic disaster in recorded times. In the most wide-ranging scenarios, the year 536 is seen as a milestone in history, a watershed moment between the ancient and modern worlds.[4] In many academic disciplines, scholars are now trying to trace the catastrophe in their own source material, from China to the British Isles, and from Arabia to North and Central America.[5] The potential traces include economic decline, population movements, political unrest, and dynastic change. This search is problematic, especially in cultures with little written history. In cases where archaeological material can be dated to an accuracy of only a century or two, as among the Stone Age populations of North America, there is a clear danger of hastily dating all suitable cultural and economic change precisely to the middle of the sixth century. Scholars who study even better-documented historical periods with a predetermined crisis point are prone to the same errors.

For classical scholars, this debate is on the edge of fairly large issues: did a dark cloud cause the collapse of ancient civilization and the transition to the Middle Ages? Most readers of this journal would probably be extremely suspicious toward such a claim, and the results of the following analysis are not likely to diminish their skepticism. In fact, many would probably not even consider the issue worth a lengthy article. However, between the two extremes of opinion—a sweeping global change or no historical effects whatsoever—the dust veil might have affected human life in many different ways. This gray area has been neglected when both popular interest and academic criticism have concentrated on the assertion of global catastrophe.[6] My purpose is to chart the more or less serious, direct consequences of the cloud, using all available sources from the Mediterranean world. The ultimate assessment of the manifold evidence depends upon perhaps an even more profound question: how far and in what ways are various natural and historical phenomena likely to be reflected in the source material? Here my survey also relates to the recent discussion on the effect of pandemics in the ancient world, such as the Antonine and Justinianic plagues.[7]

Thus, after a short introductory section on the wider historical context, this study focuses on the immediate effects of the mysterious cloud. I first briefly present the evidence that natural scientists have so far produced on the events around 536, then review the evidence derived from Mediterranean literary sources. Some sources have been cited in such summary fashion that vital information has been neglected, information that may directly relate to the nature and causes of the whole phenomenon. I further present the evidence from other contemporary sources, such as inscriptions, laws, and papyri. The inevitable conclusion from all this material is that the impact of the cloud must have been extremely limited; but some assumptions that have hitherto been taken for granted should be reexamined.

Climate and the End of the Ancient World

The natural sciences today produce increasing amounts of palaeoclimatic data to reconstruct climate variation in the past. The best known of such climatic changes in historical times is the so-called Little Ice Age around the seventeenth century. The reasons behind warmer and cooler periods are not clear. Despite various theories, including the cyclical variation in solar irradiance, the whole of climatic history before the last millennium remains a moot question.[8] Whatever the causes of climate variation, the interest in its effects on human

3 M. Baillie, *Exodus to Arthur: Catastrophic Encounters with Comets* (London, 1999), esp. 65–68. D. Keys, *Catastrophe: An Investigation into the Origins of the Modern World* (London, 1999).

4 Keys, a science journalist, is prone to include even relatively distant historical events among the effects of that fateful year. In addition to the birth of Islam, the expansion of the British Empire and the rise of the United States as the leading world power may be noted (p. 123). For a critical review of his work, see E. James, "Did Medieval History Begin with Catastrophe?" *Medieval Life* 12 (2000): 3–6.

5 See esp. J. D. Gunn, ed., *The Years without Summer: Tracing AD 536 and Its Aftermath,* BAR International Series 872 (Oxford, 2000); and M. Axboe, "Amulet Pendants and a Darkened Sun: On the Function of the Gold Bracteates and a Possible Motivation for the Large Gold Hoards," in *Roman Gold and the Development of the Early Germanic Kingdoms,* ed. B. Magnus (Stockholm, 2001), 119–36.

6 It is also fair to say that Keys himself does not directly trace the collapse of Byzantine power back to climatic effects, but indirectly, to the plague and hostile invasions that were triggered by a sudden climatic downturn.

7 For the Justinianic plague, see below, esp. n. 17; for the Antonine plague, R. Duncan-Jones, "The Impact of the Antonine Plague," *JRA* 9 (1996): 108–36; W. Scheidel, "A Model of Demographic and Economic Change in Roman Egypt after the Antonine Plague," *JRA* 15 (2002): 97–114; R. S. Bagnall, "The Effects of Plague: Model and Evidence," *JRA* 15 (2002): 114–20; J. Greenberg, "Plagued by Doubt: Reconsidering the Impact of a Mortality Crisis in the 2nd c. AD," *JRA* 16 (2003): 413–25; C. Bruun, "The Antonine Plague in Rome and Ostia," *JRA* 16 (2003): 426–34.

culture has also increased.[9] In this vein, not only sudden catastrophes, such as the dark cloud of 536, but also wider climatic phenomena, have been used to account for the historical development of ancient civilizations. According to one theory, the beginning of our era was characterized by favorable climatic conditions, the "Roman optimum." According to the same view, a long-term global cooling began about 200 CE, culminating in the "Vandal minimum" during the Early Middle Ages.[10] Another reconstruction extends the warm period up to around 400 CE; moreover, not only warm and cool periods alternate but also dry and wet.[11]

Such reconstructions (even if they were consistent) have, in the last decades, not been appealing to historians as explanations for the economic difficulties of the Roman Empire. Paradoxically, the rejected reconstructions are not inherently irreconcilable with recent trends in scholarship. On the contrary, an important strain in late-antique studies has, perhaps implicitly rather than explicitly, downplayed structural weaknesses in the later Roman Empire (the traditional endogenous reasons for its decline), stressing instead exogenous problems, that is, growing pressure from enemies and sudden military catastrophes. Theoretically, unfavorable climate would be consistent with an emphasis on exogenous problems. However, the problem with this approach lies elsewhere.

There is an ongoing debate as to whether the concept of decline is appropriate for the late Roman Empire or for late antiquity in general.[12] Regardless of terminological preferences, evidence suggests that, between the fifth and seventh centuries, the Mediterranean area "displayed a significant loss of established level of sociopolitical complexity," which, according to this definition, means either "collapse" or "decline," depending on the pace of the developments.[13] Few scholars would deny that both the economy and population were reduced during the transitional centuries and that, after this

10 Gunn, *Years without Summer*, 11–12 (n. 5 above). Even if the "Vandal minimum" were proved to be a real historical phenomenon, other terms for it might have been coined with equal justification—it is probably one of those things for which we could not blame the Vandals anyway.

11 Lamb, *Climate*, 156–70 (n. 8 above); but cf., e.g., K. Randsborg, *The First Millennium AD in Europe and the Mediterranean: An Archaeological Essay* (Cambridge, 1991), 23–29; MacDonald, "Paleoclimate," 376; D. Stathakopoulos, "Reconstructing the Climate of the Byzantine World: State of the Problem and Case Studies," in *People and Nature in Historical Perspective*, ed. J. Lasclovsky and P. Szabo (Budapest, 2003), 250; and Mann and Jones, "Global Surface Temperatures," for further models. The important book of I. Telelis, *Μετεωρολογικά φαινόμενα και χλίμα στο Βυζάντιο* (Athens, 2004), had not yet appeared when this article was finished (summer 2004). It discusses the historical climate of the eastern Mediterranean and the Near East between 300 and 1500 CE. However, Ioannis Telelis has kindly read my text and supplied me with a number of useful suggestions.

12 The rehabilitation of the concept of decline after a lengthy period of rejection is defended by J. H. W. G. Liebeschuetz, "The Uses and Abuses of the Concept of 'Decline' in Later Roman History, or, Was Gibbon Politically Incorrect?" in *Recent Research in Late-Antique Urbanism,* ed. L. Lavan, *JRA* Suppl. 42 (Portsmouth, R.I., 2001), 233–38, with responses from Av. Cameron, B. Ward-Perkins, M. Whittow, and L. Lavan, in the same volume, 238–45; see also, in more detail, J. H. W. G. Liebeschuetz, *The Decline and Fall of the Roman City* (Oxford, 2001).

13 J. Tainter, *The Collapse of Complex Societies* (Cambridge, 1988), 4, 19–20, 193. The collapse (or decline) entails such phenomena as less economic and occupational specialization, less centralized control, less investment in art and architecture, less flow of information, less trading, less overall coordination, etc.

8 From the rapidly growing amount of literature, see, e.g., C. Vita-Finzi, *The Mediterranean Valleys: Geological Changes in Historical Times* (Cambridge, 1969); T. Landscheidt, "Long-Range Forecasts of Solar Cycles and Climate Change," in *Climate: History, Periodicity, and Predictability*, ed. M. R. Rampino et al. (New York, 1987), 421–45; H. H. Lamb, *Climate, History and the Modern World*, 2d rev. ed. (London, 1995); I. Telelis and E. Chrysos, "The Byzantine Sources as Documentary Evidence for the Reconstruction of Historical Climate," in *European Climate Reconstructed from Documentary Data: Methods And Results*, ed. B. Frenzel, Paläeoklimaforschung / Palaeoclimatic Research 7 (Stuttgart, 1992), 17–31; I. Telelis, "Medieval Warm Period and the Beginning of the Little Ice Age in the Eastern Mediterranean: An Approach of Physical and Anthropogenic Evidence," in *Byzanz als Raum: Zu Methoden und Inhalten der historischen Geographie des östlichen Mittelmeerraumes*, ed. K. Belke et al., Veröffentlichungen der Kommission für die TIB 7 (Vienna, 2000), 223–43; J. D. Haigh, "Climate Variability and the Influence of the Sun," *Science* 294 (7 Dec. 2001): 2109–11; J. Esper, E. R. Crook, and F. H. Schweingruber, "Low-Frequency Signals in Long Tree-Ring Chronologies for Reconstructing Past Temperature Variability," *Science* 295 (22 March 2002): 2250–53; K. R. Briffa and T. J. Osborn, "Blowing Hot and Cold," *Science* 295 (22 March 2002): 2227–28; M. E. Mann and P. D. Jones, "Global Surface Temperatures over the Past Two Millennia," *Geophysical Research Letters* 30 (2003): 15, 1820/CLM–5, 1–4.

9 E.g., *Climate and History: Studies in Past Climates and Their Impact on Man*, ed. T. M. L. Wigley, M. J. Ingram, and G. Farmer (Cambridge, 1981); H. Weiss and R. S. Bradley, "What Drives Societal Collapse?" *Science* 291 (26 Jan. 2001): 609–10; P. B. deMenocal, "Cultural Responses to Climate Change during the Late Holocene," *Science* 292 (27 April 2001): 667–73; B. MacDonald, "Relation between Paleoclimate and the Settlement of Southern Jordan during the Nabatean, Roman and Byzantine Periods," *Studies in the History and Archaeology of Jordan VII* (Amman, 2001), 373–78.

transformation, societies in both the East and the West were in many ways simpler than a few centuries before.[14] However, there is no agreement on when exactly and why that happened and if the reasons were the same everywhere. It is becoming evident that the growth and decline in prosperity occurred in different regions of the empire at different times. Possibly the demand for the main exports of a particular province, its economic vitality, and population growth were linked in ways as yet unidentified. At any rate, although the reasons are still debatable, population and prosperity seem to have peaked in different western provinces at various times well before the fifth century, perhaps in the late fourth century in Africa. The Aegean area flourished from the fourth to the sixth century, despite hostile incursions, and the Near East especially in the sixth. To explain these nonsimultaneous fluctuations with climatic factors is difficult, and to link decline in the West with any sudden event in 536, impossible.[15]

There is more room for speculation in Asia Minor and the Near East because of disagreement as to when economic decline began. Some scholars place it in the seventh century, others already in the mid-sixth, and the chronology may indeed have varied: present scholarly interest focuses on the years around and after 550.[16] A critical factor here is the plague that ravaged the Mediterranean area in the 540s and recurred periodically thereafter. Although the demographic, economic, and political impact of the plague has been questioned, it is still generally believed that the epidemic took a heavy toll on the population, killing perhaps as much as one third of it, and may have been a severe blow to the eastern empire, which was struggling with many enemies.[17] Thus, both the general economic development in the latter half of the sixth century and the exact effects of the plague have not been determined. The dark year of 536 is a further unknown variable.

Food shortages sometimes make populations more vulnerable to epidemics. But apart from this, the economic consequences of unfavorable climate and a plague can differ in the long run. Whereas the former causes economic distress by diminishing crops, an epidemic acts like a neutron bomb: it kills people and leaves the property intact. Had there been surplus population, the survivors would have fared better after the epidemic, with more buildings, better farmland, and possibly a higher standard of living. Such happened in Britain in the fourteenth century. Not that the situation was similar in the Roman Empire: its economy and taxation system differed, and it faced special pressures of attacks from outside.[18]

In sum, this study treats neither long-term changes, nor the beginning of the Middle Ages. Instead, it scrutinizes a few decades in the middle of the sixth century. It is not precluded that a sudden exogenous factor might have

14 For the symptoms, see previous note.

15 For a fine general account, see the essays of B. Ward-Perkins, "Land, Labour and Settlement," and "Specialized Production and Exchange," in *CAH*, 2d rev. ed. (2000), 14:315–91, esp. 381–91.

16 See M. Whittow, "Recent Research on the Late-Antique City in Asia Minor: The Second Half of the 6th c. Revisited," in *Recent Research in Late-Antique Urbanism,* ed. L. Lavan, *JRA* Suppl. 42 (Portsmouth, R.I., 2001), 137–53; see further below, pp. 96–97.

17 A recent overview of the debate is given by D. Stathakopoulos, "The Justinianic Plague Revisited," *BMGS* 24 (2000): 256–76; and Stathakopoulos, *Famine and Pestilence in the Late Roman and Early Byzantine Empire: A Systematic Survey of Subsistence Crises and Epidemics*, Birmingham Byzantine and Ottoman Monographs 9 (Aldershot, 2004), 110–54. For other general accounts of the plague, see, e.g., Patlagean, *Pauvreté*, 85–91 (n. 2 above); P. Allen, "The 'Justinianic' Plague," *Byzantion* 49 (1979): 5–20; and cf. J. Durliat, "La peste du VIe siècle: Pour un nouvel examen des sources byzantines," in *Hommes et richesses dans l'Empire byzantin* (Paris, 1989), 1:107–19, with a response by J.-N. Biraben, 121–25; R. Sallares, *The Ecology of the Ancient Greek World* (London, 1991), 263–71; M. Whitby, "Recruitment in Roman Armies from Justinian to Heraclius (ca. 565–615)," in *The Byzantine and Early Islamic Near East*, vol. 3, *States, Resources and Armies,* ed. Av. Cameron and L. I. Conrad, Studies in Late Antiquity and Early Islam 1 (Princeton, N.J. 1995), 92–103; L. I. Conrad, "Die Pest und ihr soziales Umfeld im Nahen Osten des frühen Mittelalters," *Der Islam* 73 (1996): 81–112; M. Meier, "Das Ende des Konsulats im Jahr 541/42 und seine Gründe: Kritische Anmerkungen zur Vorstellung eines 'Zeitalters Justinians'," *ZPapEpig* 138 (2002): 290–99; P. Sarris, "The Justinianic Plague: Origins and Effects," *Continuity and Change* 17 (2002): 169–82. The proceedings of a conference on the Justinianic plague held at the American Academy in Rome in December 2001 (not available to me at the time of writing) will provide new evidence and interpretations.

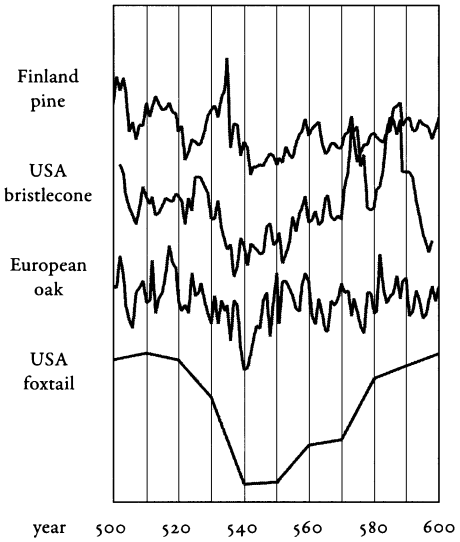
18 R. A. Griffiths, "The Later Middle Ages (1290–1485)," in *The Oxford History of Britain*, ed. K. O. Morgan (Oxford-New York, 1984), 212–16. Cf. Prokopios, *Secret History* 23.19–22; Conrad, "Pest," 107–9; Whitby, "Recruitment," 95–96; R. S. Bagnall, "P. Oxy. 4527 and the Antonine Plague in Egypt: Death or Flight?" *JRA* 13 (2000): 288–92, esp. 290; Whittow, "Recent Research," 149–52 (n. 16 above); Scheidel, "Model of Change," esp. 100–101 (n. 7 above); Sarris, "Justinianic Plague," 177–78.

depleted the economy and society of the eastern Mediterranean at that time, be it the plague or the dark year of 536, or both. In fact the two phenomena are connected in a "Theory of Absolutely Everything," tracing the epidemic's origin to a plague-carrying rodent population in eastern Africa, which was affected by the climatic turmoil of 536.[19] The proof of that hypothesis is beyond the scope of this study, and probably beyond the means of any branch of scholarship. But while I examine the direct effects of the mysterious cloud, I must also touch upon the effects of the plague.

Physical Evidence

After the initial research by Stothers and Rampino, based almost entirely on written sources,[20] physical evidence for the 536 event has emerged from dendrochronological research. The tree rings show that 536 and the following ten years marked a period of very slow growth for Scandinavian pines, north European oaks, and several North American species (fig. 1). All the information derived from study of European oak is from an area stretching from Ireland to Poland: no securely dated tree-ring series from the Mediterranean during the Roman Empire have been published.[21] Similar results have been recently reported from dendrochronological evidence in Mongolia and northern Siberia.[22] Note that Scandinavian pine growth is determined by July temperatures, whereas oak and other species' growth may more easily be affected by other factors. Moreover, the preceding year, 535, was the best growing season in the last 7,600 years for Finnish pines—a phenomenon that is not recorded in any of the other published chronologies.[23]

The initial hypothesis for the cause of the cloud—the eruption of an unknown volcano—has since been questioned. Historical eruptions are usually attested as acid layers in Greenland ice (although sometimes prevailing winds may reduce the acid signal). In the previously published studies, all the relevant sections of the Greenland ice cores for the mid-sixth century have been either missing, flawed, or poorly dated. Recently, Danish scholars have reported, based on several ice cores, that a major eruption can be dated to the early spring of 528.[24] However, these latest results have not yet been published, and it is unclear whether the whole sequence of ice layers might be redated by a few years, matching the newly attested eruption with the 536 event. Any conclusions



19 Keys, *Catastrophe*, 17–24 (n. 3 above); see also R. B. Stothers, "Volcanic Dry Fogs: Climate Cooling, and Plague Pandemics in Europe and the Middle East," *Climatic Change* 42 (1999): 713–23; and Stathakopoulos, "Justinianic Plague," 275–76 (n. 17 above).

20 See n. 1.

21 Baillie, *Exodus to Arthur*, esp. 65–68 (n. 3 above); see also M. Baillie, "Dendrochronology Raises Questions about the Nature of the AD 536 Dust-Veil Event," *The Holocene* 4 (1994): 212–17; idem, *A Slice through Time: Dendrochronology and Precision Dating* (London, 1995), 94–107; F. Serre-Bachet, "Tree-Rings in the Mediterranean Area," in *Evaluation of Climate Proxy Data in Relation to the European Holocene*, ed. B. Frenzel, Paläeoklimaforschung / Palaeoclimatic Research 6 (Stuttgart, 1991), 133–47. The latest information on the Mediterranean chronologies is accessible at the website of Peter Kuniholm's project, at http://www.arts.cornell.edu/dendro/pikbib.html.

22 R. D'Arrigo et al., "Spatial Response to Major Volcanic Events in or about AD 536, 934 and 1258: Frost Rings and Other Dendrochronological Evidence from Mongolia and Northern Siberia," *Climatic Change* 49 (2001): 239–46.

23 Pentti Zetterberg, personal communication; see M. Eronen et al., "The Supra-long Scots Pine Tree-Ring Record for Finnish Lapland: Part 1, Chronology, Construction and Initial Inferences," *The Holocene* 12 (2002): 673–80; S. Helama et al., "The Supra-Long Scots Pine Tree-Ring Record for Finnish Lapland: Part 2, Interannual to Centennial Variability in Summer Temperatures for 7500 Years," *The Holocene* 12 (2002): 681–87.

24 I owe this information to Lars Berg Larsen, who states in addition that nothing of interest can be found in the ice layers between 531 and 550.

Fig. 1 Tree ring chronologies from Europe and North America in the sixth century. Reproduced from M. G. L. Baillie, *Exodus to Arthur: Catastrophic Encounters with Comets* (London, 1999), 67; see below, n. 26.

therefore must remain tentative, but so far no acid layer sufficient to attest to a major volcanic eruption has been confirmed around 536. Instead the cloud has been attributed to the impact of a comet—another hypothesis unconfirmed by any direct evidence.[25] The question is by no means settled, and other reasons remain possible.

The contours of a sudden catastrophe cannot be directly read from the tree-ring evidence. Individual chronologies show regional variation, but in many series the drop in 536 is followed by a recovery in 537–38 and then again by an even more serious plunge. In most cases, the worst years are around 540, and 543 in Siberia. In southern Chile, the trough is in 540, whereas in Argentina there was dramatic growth reduction only after 540, with a minimum in 548. In Tasmania the tree growth declined between 546 and 552.[26] The curves thus point to problems at slightly different times. The effects of a particularly good or bad year on tree rings may be smoothed out or deferred by a process called autocorrelation, based on the trees' ability to store nutriments, though it cannot explain very long time lags. Moreover, modern eruptions indicate that, after an initial drop in temperature, a second period of cooling may follow, typically after two or three years but sometimes even later. There is considerable seasonal and regional variation, so that temperature, for example, in Europe and the Near East, may behave differently. Not all volcanic eruptions have affected tree growth in a dramatic fashion.[27]

Thus, although the year 536 was certainly a bad growing season in many parts of the world, it was part of a decade-long downturn in the climate of the northern hemisphere and was separated from the really worst seasons by three to seven years. The somewhat strange shape of the dendrochronological curves after 536 may not be totally incompatible with a volcanic explanation. But perhaps more seriously, in the Scandinavian pines, as in the oaks and North American trees, it is possible to see a long-term growth decline during the early part of the sixth century, which is matched by an equally slow rise in the average growth during the second half of the century. The years around 540 would thus be the lowest point in a slow climatic cycle. Although all this does not disprove a climatic anomaly in 536, it nevertheless suggests that the link between the dark cloud and tree growth is not so straightforward. The dendrochronological maxim "trees do not lie" may be true, but neither do they seem to provide unequivocal answers to the questions historians would like to pose to them. The climatic conditions of a particular year and region are clearly the result of various critical factors.

Literary Evidence

Although physical evidence is ambiguous, the written evidence from the Mediterranean region remains the clearest proof that something extraordinary happened precisely in 536–37.[28] For example, Michael the Syrian, a bishop writing in the twelfth century but probably quoting faithfully from John of Ephesos, an ecclesiastical historian of the sixth century, describes the event as follows:

In the year 848 [536/37 CE] there was a sign in the sun the like of which had never been seen and reported before in the world. If we had not found it recorded in the majority of proved and credible writings and confirmed by trustworthy people, we would not have recorded it; for it is difficult to conceive. So it is said that the sun became dark and its darkness lasted for one and a half years, that is, eighteen months. Each day it shone for about four hours, and still this light was only a feeble

25 Baillie, *Exodus to Arthur*, 85–88 (n. 3 above); and cf. S. V. M. Clube and W. M. Napier, "Catastrophism Now," *Astronomy Now* 5 [8] (1991): 46–49; G. A. Zielinski, "Stratospheric Loading and Optical Depth Estimates of Explosive Volcanism over the Last 2100 Years Derived from the Greenland Ice Sheet Project 2 Ice Core," *Journal of Geophysical Research* 100 (1995): 20949; H. B. Clausen et al., "A Comparison of the Volcanic Records over the Past 4000 Years from the Greenland Ice Core Project and Dye 3 Greenland Ice Cores," *Journal of Geophysical Research* 102 (1997): 26707–23; Gunn, *Years without Summer*, 13 (n. 5 above); D'Arrigo et al., "Spatial Response," 239–40 (n. 22 above).

26 See Baillie, *Exodus to Arthur*, 65–68; Keys, *Catastrophe*, 284–92 (n. 3 above); D'Arrigo et al., "Spatial Response," 241–42. Note that in his figure on p. 67 (reproduced here as fig. 1), Baillie presents the bristlecone-pine chronology as a moving average, which does not reflect accurately the values of individual years. A more faithful curve can be found in Keys, *Catastrophe*, 292.

27 Baillie, *Slice through Time*, 105–6 (n. 21 above); P. D. Jones, K. R. Briffa, and F. H. Schweingruber, "Tree-Ring Evidence of the Widespread Effects of Explosive Volcanic Eruptions," *Geophysical Research Letters* 22 (1995): 1333–36; A. Robock and J. Mao, "The Volcanic Signal in Surface Temperature Observations," *Journal of Climate* 8 (1995): 1086–1103; K. R. Briffa et al., "Influence of Volcanic Eruptions on Northern Hemisphere Summer Temperature over the Past 600 Years," *Nature* 393 (4 June 1998): 450–55; R. B. Stothers, "Climatic and Demographic Consequences of the Massive Volcanic Eruption of 1258," *Climatic Change* 45 (2000): 361–74, at 364–65; D'Arrigo et al., "Spatial Response," 241–44; A. Robock, "The Climatic Aftermath," *Science* 295 (15 Feb. 2002): 1242–44; C. Oppenheimer, "Ice Core and Palaeoclimatic Evidence for the Great Volcanic Eruption of 1257," *International Journal of Climatology* 23 (2003): 417–26.

shadow. Everyone declared that the sun would never recover its original light. The fruits did not ripen, and the wine tasted like sour grapes.[29]

Essentially the same version, deriving from John of Ephesos, also appears in the chronicle of an anonymous Syrian monk writing in the eighth century, the so-called pseudo-Dionysios of Tel Mahre.[30] It dates the event erroneously (530/31), which is not unusual in this writer's work. No further details are added by the tenth-century Arabic *Universal History* of Agapios of Menbidj, though here the year is given as 846 [534/35].[31] Fortunately, an entirely independent report is presented by the historian Prokopios, who was in Africa and Italy at that time:

And it came about during this year that a most dread portent took place. For the sun gave forth its light without brightness, like the moon, during this whole year, and it seemed exceedingly like the sun in eclipse, for the beams it shed were not clear nor such as it is accustomed to shed. And from the time when this thing happened men were free neither from war nor pestilence nor any other thing leading to death. And it was the time when Justinian was in the tenth year of his reign [536/37].[32]

Another Syriac chronicler, writing probably in the sixth century, also connected the portent with human affairs.

And [Pope Agapetus] came with them to Constantinople in the month of March in the year fourteen [536]; and Severus was there and Anthemius was chief priest. And the whole city was disturbed at the arrival of Agapetus; and the earth with all that is upon it quaked; and the sun began to be darkened by day and the moon by night, while ocean was tumultuous with spray (?), from the 24th of March in this year till the 24th of June in the following year fifteen [537]. And Agapetus, when he appeared before the king, had a splendid reception from him.[33]

The exact meaning of the phrase rendered by F. J. Hamilton and E. W. Brooks as "tumultuous with spray" is not clear. The Syriac words *'arir rattibuta* could be translated "clouded by moisture" or "confused by wet clouds," but the idea of a storm is not excluded. Humidity was definitely somehow involved. The quaking of the earth may well refer (truthfully or not) to an earthquake but possibly also to civil disturbances ("the whole land was agitated").[34] Portents in the sun, moon, and roaring sea are listed together by Luke among those that precede Jesus's second coming. The biblical passage might thus have influenced the chronicler's wording.[35] Descriptions of natural portents have their own rhetoric in the ancient world. Though this is no reason for discarding such descriptions, caution is needed when interpreting unusual phenomena associated with historical events.

Later the same chronicler asserts that the winter of the year fifteen (536/37) was very severe in Mesopotamia, "so much so that from the large and unwonted quantity of snow the birds perished and...there was distress...among men...from the evil things."[36] On the other hand, the continuator of Marcellinus Comes reports that fifteen thousand Saracens were driven from Persia to the province of Euphratensis by drought in 536.[37]

Cassiodorus, who was the praetorian prefect of Italy at the time, described the phenomenon in terms similar to those of the writers quoted above. After lamenting that the eclipse of the sun had been going on almost an entire year, he asserts, "So we have had a winter without storms, spring without mildness,

28 The literary evidence has recently been cited and briefly discussed also by M. Meier, *Das andere Zeitalter Justinians: Kontingenzerfahrung und Kontingenzbewältigung im 6. Jahrhundert n. Chr.,* Hypomnemata 147 (Göttingen, 2003), 359–65; Stathakopoulos, "Reconstructing the Climate," 251–55 (n. 11 above), and *Famine and Pestilence*, 265–69 (n. 17 above).

29 Michael the Syrian, *Chronicle* 9.26.296, ed. and trans. J. B. Chabot, *Chronique de Michel le Syrien, Patriarche Jacobite d'Antioche, 1166–1199* (Paris, 1899–1910), 2:220–21. The same account is in Bar Hebraeus, *Chronicle* 79–80, trans. E. A. W. Budge, *The Chronography of Gregory Abu'l-Faraj 1225–1286* (London, 1932, repr. Amsterdam, 1976), 1:74–75.

30 Trans. W. Witakowski, *Chronicle of Zuqnin*, pt. 3, *Pseudo-Dionysius of Tel-Mahre*, Translated Texts for Historians 22 (Liverpool, 1996), 65.

31 Ed. and trans. A. Vasiliev, PO 8:429.

32 *History of the Wars* 4.14.5–6 (trans. H. B. Dewing, *Procopius* [London, 1914–40]). This account was later repeated almost word for word by Theophanes Continuatus, *Chronographia* AM 6026, ed. C. de Boor (Leipzig, 1883), 202.

33 *The Syriac Chronicle Known as That of Zachariah of Mitylene*, trans. F. J. Hamilton and E. W. Brooks (London, 1899, repr. New York, 1979), 9.19.

34 I owe all remarks on Syriac to the expertise of Tapani Harviainen.

35 Luke 21:25; cf. also earthquakes in Luke 21:10–11. The chronicler refers to a biblical parallel in a later report (*Syriac Chronicle* 12.5) of a strange natural phenomenon in 556.

36 *Syriac Chronicle* 10.1. The missing words are indistinct in the Syriac ms.

37 Marcellinus Comes, MGH *AA* 11:105; also in *The Chronicle of Marcellinus*, trans. B. Croke, Byzantina Australiensia 7 (Sydney, 1995).

summer without heat." It is not clear if he was writing in the autumn of 536 or 537: if the cloud appeared in the spring of 536, neither fits his description perfectly. Autumn of 536 seems more likely because he incidentally notes that the previous year's harvest had been plentiful.[38] His collection also includes a letter of King Theodahad, ordering grain to be distributed from state granaries in the famine-stricken north Italian provinces of Liguria and Venetia.[39] This must have been in 536 because Theodahad was killed late that year. Cassiodorus's report is supported by the *Liber pontificalis*, which mentions a devastating famine in the whole world (*per universum mundum*) in the same year that the Goths besieged Rome (537). In Liguria it caused mothers to eat their children, a detail based on a report of Datius, bishop of Milan. Unfortunately, the writer does not specify whether the famine was due to the war, or to the climate, or to both.[40] Cassiodorus also complains of high prices for grain, but these letters cannot be dated to a precise year.[41] The crops, however, did not fail everywhere: further letters of Cassiodorus during the first indiction year (537/38) instruct officials to supply Ravenna from stocks in Histria across the Adriatic, where the previous harvest (presumably of 537) had been much better.[42]

38 Cassiodorus, *Variae* 12.25.

39 Ibid., 10.27, 12.27–28.

40 *Liber pontificalis, Vita Silverii* 100, ed. L. Duchesne, *Le liber pontificalis* (Paris, 1955), 1:291. This account is repeated by Paulus Diaconus, 16.18, MGH *AA* 2:222.

41 Cassiodorus, *Variae* 10.28, 11.11–12.

42 Ibid., 12.22–24.

The Evidence of John Lydos and the Cloud's Extent

The last account of the episode is given by John Lydos in his treatise *On Portents*, written in Constantinople probably somewhere around the 540s. Since this passage is both crucial and ambiguous, and has so far been cited only in a misleadingly truncated version by those who have used it as evidence, it should be studied in full. I have underlined those parts that have been repeated by scholars since the original translations of Stothers and Rampino.[43]

If the sun becomes dim because the air is dense from rising moisture—as happened in the course of the recently passed fourteenth indiction [535/36] for nearly a whole year, when Belisarios held the consular office (τὴν ὑπατον ἔχοντος Βελισαρίου τιμήν), so that the produce (καρπούς) was destroyed because of the bad time—it predicts heavy trouble in Europe. And this we have seen from the events themselves, when many wars broke out in the west and that tyranny was dissolved, while India, and the Persian realm, and whatever dry land lies toward the rising sun, were not troubled at all. And it was not even likely that those regions would be affected by the calamity because it was in Europe that the moisture in question (τῆς ὑποκειμένης ὑγρότητος) evaporated and gathered into clouds dimming the light of the sun so that it did not come into our sight or pierce this dense substance.[44]

43 Cf. Stothers and Rampino, "Volcanic Eruptions," 6362; Stothers, "Mystery Cloud," 344 (both n. 1 above); Baillie, *Exodus to Arthur*, 85; Keys, *Catastrophe*, 282 (both n. 3 above); B. K. Young, "Climate and Crisis in Sixth-Century Italy and Gaul," in *Years without Summer*, 35–42, at 37 (n. 5 above). This translation is mine: I am not aware of any translation of the work into another language. The most recent edition is by C. Wachsmuth, *Ioannis Laurentii Lydi Liber de Ostentis et Calendaria Graeca omnia* (Leipzig, 1897).

44 John Lydos, *On Portents* 9c (p. 25 Wachsmuth ed.). Ioannis Telelis has suggested to me that τῆς ὑποκειμένης ὑγρότητος should rather be translated "the moisture lying underneath," which is certainly possible and would render the account slightly more specific; however, I have adopted the more neutral alternative.

Belisarios's consular year was 535, but since there were no consuls in 536–37, Lydos may have meant his first postconsulate in 536. A simple blunder is also possible, although Lydos seems to have written his treatise not very long after the event. Note also that the Greek word καρπούς (translated literally and as such correctly as "fruits" by Stothers and Rampino) may refer to any produce and often to the grain harvest, while the Syriac word used in the passage of Michael cited earlier ("The fruits did not ripen") does not cover grain.

But the other details of Lydos's account are even more remarkable. He attributes the darkness to moisture (ἀνάδοσις ὑγρότητος) and claims that the phenomenon was restricted to Europe. Of course we cannot be sure that Lydos knew accurately the cloud's physical origin: he may have just invented the best explanation he could. A volcanic eruption can spew material into both the troposphere (the lowest region of the atmosphere, below ca. 10 km) and the

stratosphere (the upper region of the atmosphere). All the known volcanogenic fogs have been remarkably dry, composed of sulfuric acid aerosols. If the fog was tropospheric, even an antiquarian writer could have discerned a water fog from a dry fog of volcanic origin. An intense tropospheric fog lasting for more than a year, though not impossible, would be an exceptional event. It would require an equally long-lived eruption, or some unknown source.

If the sun was dimmed by a dense stratospheric fog, which might well linger in the atmosphere for one or two years, ancient observers could not possibly have distinguished its composition from ordinary high cloudiness (like high cirrus). In that case, they might only conjecture on its origins. Of the other reports quoted above, the sixth-century Syriac chronicle explicitly mentioned moisture above/from the ocean. This may give some support to the theory that Lydos also accurately described a moist fog above sea and land. On the other hand, Cassiodorus complained not only of north winds but also of a lack of rain.[45] He also mentioned that the sun appeared bluish (*venetum*). This would better suit a dry fog, with its very different particle size and optical thickness, which makes the color of the sun change, whereas a wet fog renders the sun only grayish. Thus the Syriac chronicler, alternatively, may have referred to strong winds that continually whipped up spray from the ocean. In sum, all the sources are in some way ambiguous because we cannot distinguish real observation from speculative reasoning. A reliable scientific description of the phenomenon is lacking, and its immediate effects may have varied regionally.[46]

Again, it is not certain how familiar Lydos was with the situation farther east. His knowledge of weather conditions or political developments need not have extended to India. On the other hand, there is nothing strange if it did: when people in the Mediterranean area were distressed by a darkness lasting for months, they were likely to be curious about similar phenomena in neighboring regions, and rumors of the cloud must have circulated widely, from the Atlantic to the Middle East and even beyond.

It might be claimed that Lydos had before him a preexisting theory concerning a special portent and was trying (perhaps unconsciously rather than consciously) to force historical details to fit into that pattern. It would be useful to know how much he followed an earlier source in this passage.[47] However, practically all the established theories that Lydos discussed in his work and that have a geographical dimension, predicting different fates in different regions, also presuppose some corresponding difference in the portentous sign itself. For example, a comet coming from the east has different consequences than a comet coming from the west, or the sun symbolizes Asia and the moon, Europe.[48] In this short passage, Lydos three times explicitly stresses that he is speaking only of Europe. It is difficult to see why he would have invented such a special feature of the cloud. If he had believed that the sky was darkened in the eastern empires as well, he would have needed only to say that there was probably political trouble in India, too, and none could have questioned his theory. On the other hand, if he did not know the cloud's eastern extension, he did not need to say anything about it. Thus, even if Lydos was connecting the contemporary phenomenon with a sufficiently close, older theory (which would probably not have had a geographical dimension at all), he had no obvious need to distort the facts. But it appears at least as likely that he presents his own ad hoc hypothesis concocted from actual observations and their imagined relationship.

It is, in fact, remarkable that no literary source mentions the dark cloud outside Europe: even the sixth-century Syriac chronicler states that the events he described took place in Constantinople. John of Ephesos, the probable

45 Cassiodorus, *Variae* 12.25.3.

46 I owe much information here to Richard Stothers. See also R. B. Stothers, "Cloudy and Clear Stratospheres before AD 1000 inferred from written sources," *Journal of Geophysical Research* 107 (2002): D23, 4718/AAC–17, 1–10.

47 The editor's suggestion (Wachsmuth, p. xxxiii n. 43), that Lydos had taken the whole passage from a much earlier work of Campestris, mentioned some 20 lines earlier, is not substantiated in any way and is actually untenable: the simple fact that Lydos describes events taking place in 536 shows that most of the text must be from his own pen. Furthermore precisely this passage is missing from all but one manuscript, unlike the immediately preceding text, which is more or less directly cited from Campestris. A few pages later (Wachsmuth, p. 38, lines 1–8) the editor concedes that Lydos had inserted his own text into another lengthy passage taken from Campestris.

48 E.g., Lydos, *On Portents* 9–9a, 15, cf. Hephaestion and Avienus at pp. 167–71.

source for Michael the Syrian, lived mainly in northern Mesopotamia until the late 530s, but he both traveled widely and recorded events he had not witnessed, so his report does not prove with certainty that the cloud was sighted east of the Mediterranean.

Cold and drought are attested in other parts of the world but not the persistent fog. Chinese sources record that the star Canopus was not seen at the spring and fall equinoxes in 536.[49] Although this might be taken to refer to reduced atmospheric transparency (as many scholars have assumed), it seems an understated way to describe a darkness that continued for a year. It is especially odd if it was the factor that caused summer frosts, drought, and widespread famine, duly recorded in Chinese historical works between 535 (sic) and 538.[50] At least two possibilities emerge: either the Chinese did not mention the fog because opaque skies are not unusual in northern China due to the frequent desert storms there,[51] or the fog was tropospheric and localized in the Mediterranean area. Although zonal winds would have spread a stratospheric fog over the northern latitudes within a few weeks or months, a tropospheric fog (volcanic or not) might well have attenuated before reaching China. The problem remains that no tropospheric fog of such duration has been observed in historical times.

However, if we accept the possibility that the fog may have been seen in northern China though it was not clearly recorded, it might also be possible to explain Lydos's account in a different way. All those areas for which the fog is securely attested (Italy, Constantinople) lie above 35 degrees of northern latitude, perhaps even above 40 degrees, depending on how we interpret Prokopios's report.[52] The same is true of northern Mesopotamia (ca. 37° N). In contrast, those areas farther east that Lydos claims did not witness the fog (Persia, India) all lie below 40 or even 35 degrees northern latitude, and this also applies to most of China (fig. 2). Thus, instead of a west/east divide we might actually have a cloud that could be seen only at latitudes north of the Mediterranean and in

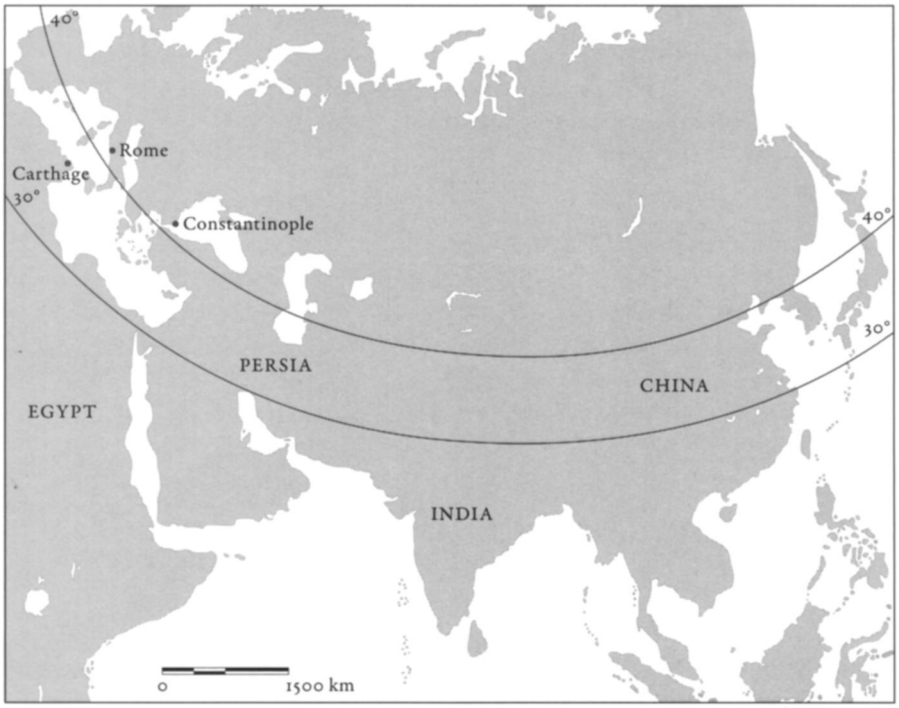
49 M. S. Houston, "Chinese Climate, History, and State Stability in AD 536," in *Years without Summer*, 71–77, at 73 (n. 5 above); the Chinese sources were originally detected by K. D. Pang and H.-H. Chou.

50 Cf. also Keys, *Catastrophe*, 149–60, 283 (n. 3 above).

51 See W. Qian, L. Quan, and Sh. Shi, "Variations of the Dust Storm in China and its Climatic Record," *Journal of Climate* 15 (2002): 1216–29.

52 Prokopios does not indicate where precisely the eclipsed sun could be seen. He was in Carthage at Easter 536 but soon moved to Sicily and Italy and was with Belisarios in Rome during 537; see *Wars* 4.14.7, 4.14.39–41, 6.4.1–4. If the event had been restricted, say, only to northern Italy, Prokopios would probably have specified it. Thus the cloud most likely extended at least to southern Italy, i.e., below 40 degrees.

Fig. 2 Map of Eurasia in the sixth century, showing the 30 and 40 degrees of northern latitude (map by V. Vahtikari and www.archeographics.com)



the very north of China. Such an abrupt and globally uniform cutoff latitude falling between 30 and 40 degrees has been observed for stratospheric aerosol veils stemming from large eruptions of northern volcanoes, notably Lakagigar (Iceland, 1783), Ksudach (Kamchatka, 1907), and Katmai (Alaska, 1912). For example, the dust cloud from Katmai was seen and measured at Bassour, Algeria (36° N), at Simla, India (31° N), and at two U.S. observatories (34–36° N), but not at Helwan, Egypt (30° N).[53]

If we interpret Lydos's text in this manner, disregarding his report of the moist fog and assuming that the missing or misdated acid layers in the ice cores can be explained somehow, we would add a new dimension to the volcano hypothesis, supporting Richard Stothers's suggestion that the mystery cloud derived from a far northern volcano, and not from a tropical one such as Rabaul (New Guinea), Krakatau (Indonesia), or El Chichón (Mexico), which have been earlier suspects.[54] The observed decline of tree growth in South America in the 540s might seem to be at odds with this. However, it has not yet been established whether a high-latitude eruption could have global climatic effects. The issue is currently debated.

The Duration of the Fog

Clearly the Mediterranean sources do not completely agree on the length of the darkness. The reports range from less than a year to eighteen months. It is possible that the fog did not appear at the same time in all regions—the difference depending more on latitude than on longitude. But it is equally possible that when the fog gradually started to clear, the observers determined the end point differently depending on personal interpretation. Cassiodorus and the *Liber pontificalis* seem to attest continuing problems with the harvest in 537, which is not at all surprising if the fog persisted until the summer. Immediate effects of the event are not reported thereafter. Prokopios (perhaps preoccupied with his narrative of the siege of Rome) does not mention the crop failures of 536/37. He says that outside the besieged city the Goths were also starving, but he seems to credit it to a successful Byzantine naval blockade.[55] In contrast the historian describes at great length a terrible famine in Italy in 539. However, he states explicitly that the fields had been left uncultivated because of the war.[56] A little later he returns to the subject of food shortages among the Goths, again insinuating that the lack of supplies was a logistical problem.[57] He does not give a hint that climatic conditions might have been blamed for continual bad harvests.

Though these sources state clearly that a mysterious fog was seen in an area that extended from at least Italy to Asia Minor and caused bad harvests there for one or two years, they all seem to treat it as a temporary bad omen, not as the beginning of a long period of unfavorable climatic conditions. Of course the writers might not have noted a slight drop in average temperatures, and might perhaps not have cared to record a change in prevailing winds or precipitation. However, if the direct consequences of such underlying factors for agriculture had been grave enough to undermine the economic well-being of the empire, we would probably expect that contemporary writers would devote more attention to them.

Indeed many chroniclers and historians of the sixth century had a different focus, concentrating on either political or ecclesiastical history.[58] Thus Isidorus and Jordanes register only political events. Gregory of Tours does not record any climatic events around 536, though he mentions an exceptionally severe winter in 548; Victor Tonnennensis and Evagrios Scholastikos report only the

53 R. B. Stothers, "Major Optical Depth Perturbations to the Stratosphere from Volcanic Eruptions: Pyrheliometric Period 1881–1960," *Journal of Geophysical Research* 101 (1996): 3901–20; idem, "The Great Dry Fog of 1783," *Climatic Change* 32 (1996): 79–89; G. R. Demarée, A. E. J. Ogilvie, and D. Zhang, "Further Documentary Evidence of Northern Hemispheric Coverage of the Great Dry Fog of 1783," *Climatic Change* 39 (1998): 727–30. The ratio of tropospheric to stratospheric sulfur output from Lakagigar is under debate with some scholars assuming a predominantly tropospheric fog. I am indebted here, too, to Richard Stothers for valuable help and suggestions.

54 Stothers, "Volcanic Dry Fogs," 717 (n. 19 above). 55 Prokopios, *Wars* 6.6.1–3, 6.7.17.

55 Prokopios, *Wars* 6.6.1–3, 6.7.17.

56 Ibid., 6.20.15–33; see Stathakopoulos, *Famine and Pestilence*, 272–74 (n. 17 above); for the other famines of this period, mostly caused by sieges and warfare, see ibid., 270–77.

57 Prokopios, *Wars* 6.24.13–15.

58 M. Kouroumali, "Catastrophe and Conspiracy: The Evidence of the Sixth Century Byzantine Sources for the AD 536 Environmental Event," *Medieval Life* 16 (Winter 2001/2): 2–5. Without going into details, she refutes Baillie's suggestion that the event of 536 caused a break in historical documentation.

plague.[59] John, bishop of Nikiu in Egypt, cites several natural catastrophes and phenomena in the fifth and sixth centuries, including earthquakes, a plague, a comet, and a short solar eclipse, but not the mystery cloud of 536.[60] The fog is also not listed among the calamities cited in the *Chronicle of Edessa*.[61] According to Prokopios, Justinian's reign was severely afflicted by several disastrous floods and earthquakes and by the plague.[62] The continuation of John Malalas is for some reason almost silent concerning any events during the period 533–39, and following him, the *Chronicon Paschale* as well. Malalas mentions the plague in 542 and a shortage of wine in 543. Although Malalas's *Chronicon* could be taken as an indication that there had been no particular dearth of wine (or other products) immediately before, arguments ex silentio are not particularly weighty from texts like Malalas's.[63] In general the omission from these sources does not disprove the cloud's existence or show that the writers were unaware of it, but evidently, even if the dark cloud was seen all around the Mediterranean (which is by no means certain), it was not remembered as the most important event in the recent history of that era.[64]

More allusions to the climatic conditions of the late 530s might emerge from a careful reading of all Western and Eastern hagiographical sources. A Merovingian Life mentions that while Queen Clothilde was building a monastery, an exceptionally bad year for wine occurred in Gaul.[65] Unfortunately the year could be any time between 511 and her death in 544. From the other end of the Mediterranean world, the *Life of Symeon the Stylite the Younger* preserves the memory of both the plague and the Persian incursions into Syria, but not the fog and cold a few years earlier. Similarly the *Lives of the Monks of Palestine* by Cyril of Skythopolis and the *Life of Nicholas of Sion* (in Lycia) allude to the plague but not to any contemporary climatic disasters.

Inscriptional and Archaeological Evidence

Among other sources for the history of the sixth century, inscriptions might be considered potentially relevant. However, grave inscriptions, even when dated, are of little use for a study of the dark cloud. I have not read through all mid-sixth-century inscriptions from the Mediterranean area but, as far as I can see, both Latin and Greek epitaphs of this period tend to follow perfectly traditional, laconic formulas. Statistics on mortality are notoriously unreliable, because the practice of putting up epitaphs is sensitive to many possible factors. More especially, at the time of the fog, Italy was in the midst of a bloody war, which must have affected both mortality and the epigraphic habit. In Palestine there seems to be a greater number of dated tombstones between 541 and 544 than in the immediately preceding and following periods. Although their absolute number is not very high (less than twenty), the Palestinian tombs have been connected with the plague.[66] I am not aware of similar groups of grave inscriptions there or elsewhere in the 530s.

Building inscriptions are a more promising source. Richard Duncan-Jones purported to show that building activity, at least in Italy, declined during the second-century Antonine plague. Some of his figures suggest this, though the number of relevant dated inscriptions even in the second century is not very high.[67] Of course the Italian material in the 530s is again useless for our

59 Gregory of Tours, *History of the Franks* 3.37, MGH *ScriptRerMerov* 1.1:132; Victor Tonnennensis, *Chronicle* 130 (CCSL 173A:43); Evagrios Scholastikos, *Ecclesiastical History* 4.29, trans. M. Whitby, *The Ecclesiastical History of Evagrius Scholasticus*, Translated Texts for Historians 33 (Liverpool, 2000), 229–32.

60 *Chronicle* 87.38–41, 90.5, 90.24–29, 90.81–83, 94.18; trans. R. H. Charles, *The Chronicle of John (c. 690 AD), Coptic Bishop of Nikiu: Being a History of Egypt before and during the Arab Conquest* (London, 1916; repr. Amsterdam, n.d.).

61 Ed. I. Guidi et al., *Chronica Minora* CSCO 1–2 (Leipzig, 1903).

62 *Secret History* 18.36–45.

63 Malalas, *Chronicle* 18.80–86, 18.90–92, and 18.95; trans. E. Jeffreys et al., *The Chronicle of John Malalas*, Byzantina Australiensia 4 (Sydney, 1986). For the variations in the coverage of events in 532–65 by the continuation of Malalas, see, e.g., M. Whitby, "Justinian's Bridge over the Sangarius and the Date of Procopius' de Aedificiis," *JHS* 105 (1985): 138–39.

64 On the variety of factors causing food shortages and human suffering in the Byzantine Empire, see, e.g., Patlagean, *Pauvreté*, 74–92 (n. 2 above); M. Kaplan, *Les hommes et la terre à Byzance du VIe au XIe siècle: Propriété et exploitation du sol*, Byzantina Sorbonensia 10 (Paris, 1992), 446–64; Stathakopoulos, *Famine and Pestilence* (n. 17 above).

65 *Vita Clothildae* 12, MGH *ScriptRerMerov* 2:341–48.

66 See Y. E. Meimaris, *Chronological Systems in Roman-Byzantine Palestine and Arabia: The Evidence of the Dated Greek Inscriptions*, Meletemata 17 (Athens, 1992), 129–30, 236–38; Durliat, "Peste," 108–9; Conrad, "Pest," 95; Stathakopoulos, "Justinianic Plague," 270 n. 31; Stathakopoulos, *Famine and Pestilence*, 278–80 (all n. 17 above). A few mass inhumations in the Spanish cities of Valencia and Cartagena, with no inscriptions, have been dated to the early or mid-6th century and attributed to the plague; see M. Kulikowski, "Plague in Spanish Late Antiquity," forthcoming in the proceedings of the conference on the Justinianic plague (n. 17 above).

67 "Antonine Plague," 125–30; but see the criticism of Greenberg, "Plagued by Doubt," 416–19, and Bruun, "Antonine Plague in Rome" (all n. 7 above)

purposes because of the ravages of the war, but another problem affects the inscriptions from the eastern Mediterranean as well. To arrive at statistically meaningful samples, Duncan-Jones had to include inscriptions dated only by reign. This worked in the second century because the reign of Marcus Aurelius and the plague were sufficiently contemporaneous, and there were no other (perceived) complicating factors. However, the reign of Justinian is too long to provide a useful dating criterion. Moreover the Persian onslaught on Syria in 540 and the outbreak of the plague in 541 are so close to the hypothetic climatic downturn beginning in 536 that their effects cannot be separated. There remains only an extremely short time gap in the late 530s, when we might detect phenomena connected with crop failures and food shortages. A sample of relevant inscriptions reveals that building activity was by no means halted in the years following 536, since churches and other buildings were constructed or repaired in 536–40 in Asia Minor, in the Near East, and in reconquered Africa.[68] In the north-Syrian limestone massif, building inscriptions stop in 540 and reappear only after a decade; a connection with the Persian raid has been postulated.[69]

Archaeological research faces the same difficulty as epigraphy, the results of which it often uses to date material remains. Settlement patterns and normal construction activity were certainly affected by war in Italy, in the Balkans, and in Africa.[70] In the Near East, it is generally believed that the cities and countryside were experiencing a long boom that continued until at least the mid-sixth century and much later in some areas. A similar apparent boom is evident in Asia Minor, where the Carian city of Aphrodisias abounds in public and private inscriptions between the mid-fifth and early sixth centuries.[71] Due to the lack of inscriptions and proper archaeological excavations, the late Roman chronology of most other sites in Asia Minor is uncertain. The decline of the Greco-Roman epigraphic habit does not automatically mean that there was a decline in civic life in general. There are signs of continuing prosperity in the sixth century, but also some signs of a contracting economy and population. In that these cannot be precisely dated, the economic development of the region after the mid-sixth century remains obscure. Whatever happened in the latter half of the sixth century, Asia Minor suffered much damage during the Persian invasions of the early seventh century.[72]

In Syria the prosperous period was disrupted in Antioch by two severe earthquakes in the 520s and by the Persian sack in 540. In the surrounding area, a period of economic stagnation seems to have set in around the middle of the sixth century. It has been attributed to the plague, or to the ravages of the Persians, which probably affected village economy, even if the countryside was not devastated to the same extent as the principal cities. Significantly, farther south, in the regions of Epiphaneia and Bostra and in Palestine, there is less or no trace of decline during the sixth century.[73] If it is true that the rural settlements in the Syrian limestone massif retained their large population but

68 Asia: C. Foss, *Ephesus after Antiquity: A Late Antique, Byzantine and Turkish City* (Cambridge, 1979), 88 n. 88; Caria: H. Grégoire, *Recueil des inscriptions grecques-chrétiennes d'Asie mineure* (Paris, 1922), 219; Cilicia: G. Dagron and D. Feissel, *Inscriptions de Cilicie*, Travaux et Mémoires du Centre de Recherche d'Histoire et Civilisation de Byzance, Monographies 4 (Paris, 1987), 105 (late 536); Syria: *IGLSyr* 2:456, 462, 571, 786; 4:1344; 6:2945; Arabia: *IGLSyr* 13:9128–31; Africa: *ILCV* 805, cf. 791, 794, 797, 804, 806; J. Durliat, *Les dédicaces d'ouvrages de défense dans l'Afrique byzantine,* Collection de l'École Française de Rome 49 (1981). For the reconstruction of Antioch after the Persian sack of 540, see Prokopios, *On the Buildings of Emperor Justinian* 2.10.

69 F. R. Trombley, "War and Society in Rural Syria c. 502–613 AD: Observations on the Epigraphy," *BMGS* 21 (1997): 166, 176–80.

70 For the Balkans, see, e.g., *Villes et peuplement dans l'Illyricum protobyzantin: Actes du colloque organisé par l'École Française de Rome* (Rome, 1984); M. Whitby, "The Balkans and Greece 420–602," in *CAH*, 2nd rev. ed. (2000), 14:701–30.

71 C. Roueché, *Aphrodisias in Late Antiquity,* JRS Monographs 5 (London, 1989), xxv–xxvii.

72 See now esp. Liebeschuetz, *Decline and Fall*, 30–54 (n. 12 above); Whittow, "Recent Research" (n. 16 above); further C. Foss, *History and Archaeology of Byzantine Asia Minor*, Collected Studies Series 315 (Aldershot, 1990); idem, *Cities, Fortresses and Villages of Byzantine Asia Minor,* Collected Studies Series 538 (Aldershot, 1996); C. Roueché, "Asia Minor and Cyprus," in *CAH*, 2d rev. ed. (2000), 14:570–87; and cf. M. Whittow, "Ruling the Late Roman and Early Byzantine City: A Continuous History," *Past and Present* 129 (1990): 3–29.

73 C. Foss, "Syria in Transition, AD 550–750: An Archaeological Approach," *DOP* 51 (1997): 189–271; H. Kennedy, "Syria, Palestine and Mesopotamia," in *CAH*, 2d rev. ed. (2000), 14:588–611; Liebeschuetz, *Decline and Fall*, 54–63; see also Whittow, "Ruling the City," 13–20; C. Strube, *Die "Toten Städte": Stadt und Land in Nordsyrien während der Spätantike* (Mainz, 1996) 76–89; Trombley, "War and Society"; and cf. Z. T. Fiema, "Late-Antique Petra and Its Hinterland: Recent Research and New Interpretations," in *The Roman and Byzantine Near East*, ed. J. H. Humphrey, *JRA* Suppl. 49 (Portsmouth, R.I., 2002), 3:191–252.

in declining economic conditions well into the early Islamic period, that might indicate explanations other than the plague. However, this interpretation is so far derived mainly from just one excavated village (Dehes).[74]

The dating of settlement changes remains controversial, as does linking them with assumed climatic changes. Even in the intensively studied Near Eastern area, given the chronological proximity of the dark cloud, plague, and foreign incursions, a secure analysis of their respective consequences appears practically impossible. Short-term effects would not figure in archaeological, palaeogeographical, or palaeobotanical material.[75] To distinguish the impact of the cloud from other factors, we would need sources that can be dated more accurately, to the year, month, and day, such as laws and papyri.

Legal Evidence

The second edition of the Justinian Code was published in 534. In the following years, Justinian continued his legislative activity with a steady flow of new laws, *Novellae*, which discuss administrative, economic, and social problems in the smallest detail and are reasonably well preserved. Thus there are thirty-five constitutions from the year 535, sixteen constitutions from 536, and twenty-one from 537, followed by thirteen from 538 and twenty-six from 539. Thereafter, the number of laws diminishes, varying between zero and ten per year.[76] This amounts to around five hundred edition pages of text for the late 530s alone. Among this vast mass, only one group of laws might refer to the climatic conditions in and after 536. These laws address financial problems caused by a crop failure in Thrace and Illyricum. They are dated to June 535 in most manuscripts, but because there often seems to be confusion between Belisarios's consulate and postconsulate, it would be possible to emend the date to 536.[77] All the other constitutions from these years avoid any mention of agricultural difficulties. A series of laws beginning in 535 discusses the administrative organization of individual provinces and the duties of their governors. One of them, dated to June 536, deals with the province of Arabia. According to the preamble, the emperor had been induced to examine why such a flourishing region produced so little revenue. Having listened to a number of explanations, he concluded that the problem was weak administration. Not a word is said about climatic anomalies. A similar case appears in a long constitution on the administration of Egypt, probably to be dated to 538/39. It regulates the collection and transport of crops in a manner that reveals no concern other than about technical matters.[78]

Indeed the emperor was wise to concentrate his legislation on issues that he could influence. It would have been futile to enact laws against climate. But the laws do seem to refer a few times to the plague. One constitution improves the position of bankers in the face of problems that had, at least partly, been caused by suddenly increased mortality. The calamity did not need further description because it had, in the emperor's words, been felt "everywhere" by "everyone." The text is dated to 1 March 542. That appears somewhat too early for the Great Plague to have reached "everywhere," even allowing for rhetorical exaggeration. In fact the manuscript dating is again open to doubt, in that Justinian's sixteenth year is easily confused with his fifteenth year.[79] An emended date of 1 March 543 would perfectly fit the plague's spread. Another law in 543 discusses at length the rules of intestate succession, a topic that may well have become a burning question during an epidemic, although there is no direct reference in the text to the plague. In the following year, tradesmen, agricultural workers, and sailors are blamed for a two- or threefold price and wage rise.[80] Fifteen years later, in

74 Foss, "Syria in Transition," 202–4.

75 Cf. R. Rubin, "The Debate over Climatic Changes in the Negev, Fourth–Seventh Centuries CE," *PEQ* 121 (1989): 71–78; S. Bottema, "Pollen Proxy Data from Southeastern Europe and the Near East," in *Climate Proxy Data*, 63–79 (n. 21 above); C. Foss, "The Near Eastern Countryside in Late Antiquity: A Review Article," in *The Roman and Byzantine Near East: Some Recent Archaeological Research*, ed. J. H. Humphrey, *JRA* Suppl. 14 (Portsmouth, R.I., 1995), 213–34; Y. Tsafrir, "Some Notes on the Settlement and Demography of Palestine in the Byzantine Period: The Archaeological Evidence," in *Retrieving the Past: Essays on Archaeological Research and Methodology in Honor of Gus W. Van Beek*, ed. J. D. Seger (Winona Lake, Ind., 1996), 269–83; Koder, "Climatic Change" (n. 2 above); MacDonald, "Paleoclimate" (n. 9 above).

76 The reason for this decline in volume is not immediately clear. The numbers drop in 540, so there cannot be any connection with the plague or the death of Tribonian in 542. Cf., e.g., the tables in T. Honoré, *Tribonian* (London, 1978), 133, 135.

77 *CIC, Nov.* 32–34. Cf. the ms. dates in *Nov.* 35–40. Admittedly, an error is less likely when we are speaking of three laws; two of them are dated actually to 536 in the Epitome of Theodoros, which itself dates from around 575. 78 *CIC, Nov.* 102 (Arabia); *Nov. Ed.* 13.4.2 (Egypt).

78 *CIC, Nov.* 102 (Arabia); *Nov. Ed.* 13.4.2 (Egypt).

79 *CIC, Nov. Ed.* 7.pr; cf. Prokopios, *Wars* 2.22–23. See *CIC, Nov.* 116–20, esp. 117, where the principal ms. (M) has "dn. iust. aug. ann. XV" although the correct number was certainly XVI.

80 *CIC, Nov.* 118 (543); *Nov.* 122 (544).

March 559, Justinian enacted a law against homosexuality. He suggested that the sins of humanity had aroused God's current wrath. Although this wrath is not specified, it coincides with another outbreak of the plague in 558.[81] The next epidemic was felt in Constantinople in 573–74, and this may have been, together with the Persian incursions of 573, the "continuous and manifold mortality" that induced Emperor Tiberius to grant a considerable tax exemption to landlords in 575.[82]

In all, the legislation does not display an active interest in natural catastrophes, but the plagues receive slightly more attention than the 536 event. The numismatic evidence does not offer anything more conclusive. In the reign of Justinian some rearrangements of the coinage system have been tentatively dated to around 538/39. The weight of the copper follis was raised from 18 g to 22 g, and it was retariffed against the gold solidus. After this there appears alongside the normal solidus weighing 24 siliquae a spasmodic series of so-called lightweight solidi weighing only 20–22 siliquae. The purpose of these lighter coins is not known, but their issue continued until the late seventh century.[83] The poor state of public finances, whether due to the war or to other reasons, remains one possible explanation for their introduction.

Papyrological Evidence

Prokopios records an excessive flood, a poor harvest, and even food shortages in Egypt in 545/46 and 548,[84] while he does not mention any comparable calamities there in the 530s. In view of his selective report on Italian famines, this may be only an accidental omission. I next explore the papyrological evidence to determine whether anything anomalous was recorded in Egypt during the late 530s. In the Nile valley, the implications of a dark cloud are especially difficult to assess. At those latitudes, less heat may have caused no harm, although local vegetation is naturally adapted to a certain temperature and amount of sunlight, and frost would certainly have harmed the crops. In the arid regions of the southwestern United States, it has been observed that trees benefited from a cool period.[85] As we have seen, cold and drought were mentioned in contemporary sources as the main negative effect of the dark cloud. However, moisture in Egypt is not based on rain but on the Nile. The level of the flood varies naturally and depends on monsoon rains far to the south.[86] It is possible that a global climatic cooling might affect the monsoon rains. We know that the flood and crops failed in Egypt for two years in the late 40s BCE. It was also a time of severely cold weather in Greece and China. This may have been connected with the eruption of Etna in 44 BCE and the subsequent portentous darkness after the Ides of March (its timing was a historical coincidence that did not escape contemporary observers).[87] However, it is impossible to create a model of the rains' behavior from our imperfect information. The natural sciences cannot tell us what happened in Egypt in those years.

I have gone through all the papyrus documents datable between 521 and 560. My aim was to look not only at the immediate aftermath of 536 but also at more general trends before and after that point, finding perhaps a rise in the price of wheat or wine, increasing tax arrears, unpaid rents, or different clauses in lease contracts. However, as I surveyed only datable documents, it is theoretically possible that I have omitted some piece of evidence in a papyrus dated vaguely to the sixth century or to the Byzantine period.

Should we expect any variation in the number of surviving papyri from a period of crisis? When people have to struggle to survive, they might have less time to record their smallest transactions in writing, and even the official

81 *CIC, Nov.* 141; Malalas, *Chronicle* 18.127; Agathias, *Histories* 5.10. There had also been a devastating earthquake in Constantinople in December 557 (Malalas, *Chronicle* 18.124), and attacks by the Cotrigurs; see Stathakopoulos, *Famine and Pestilence*, 304–6 (n. 17 above).

82 *CIC, Nov.* 163. For the plague, see John of Biclarum, *Chronicle*, 33, CCSL 173A:66; Agapios, *Universal History*, PO 8:437; and for the Persian war, Trombley, "War and Society," 175–80 (n. 69 above).

83 M. F. Hendy, *Studies in the Byzantine Monetary Economy c. 300–1450* (Cambridge, 1985), 476–78, 492–93. Cf. also Patlagean, *Pauvreté*, 409–21 (n. 2 above); Durliat, "Peste," 110–11; Sarris, "Justinianic Plague," 175–77 (both n. 17 above).

84 *Secret History* 22.14–19; *Wars* 7.29.6–8.

85 Gunn, *Years without Summer*, 12–13 (n. 5 above).

86 See F. A. Hassan and B. R. Stucki, "Nile Floods and Climatic Change," in *Climate*, ed. Rampino et al., 37–46 (n. 8 above).

87 Forsyth, "Wake of Etna" (n. 2 above), citing primary sources, e.g., Plutarch, *Caes.* 69.3–4. See also Stothers and Rampino, "Volcanic Eruptions," 6358–60 (n. 1 above); Stothers, "Volcanic Dry Fogs," 717–18 (n. 19 above); P. Bicknell, "Blue Suns, the Son of Heaven, and the Chronology of the Volcanic Veil of the 40s BC," *Ancient History Bulletin* 7 (1993): 2–11. For the situation in Egypt in 43–42 BCE, see Appian, *Civil War* 4.61, 4.63, 4.108; Seneca, *Nat. Quest.* 4A 2.16; *SEG* 24:1217. For the general situation between 44 and 36 BCE, see also P. Garnsey, *Famine and Food Supply in the Graeco-Roman World: Responses to Risk and Crisis* (Cambridge, 1988), 202.

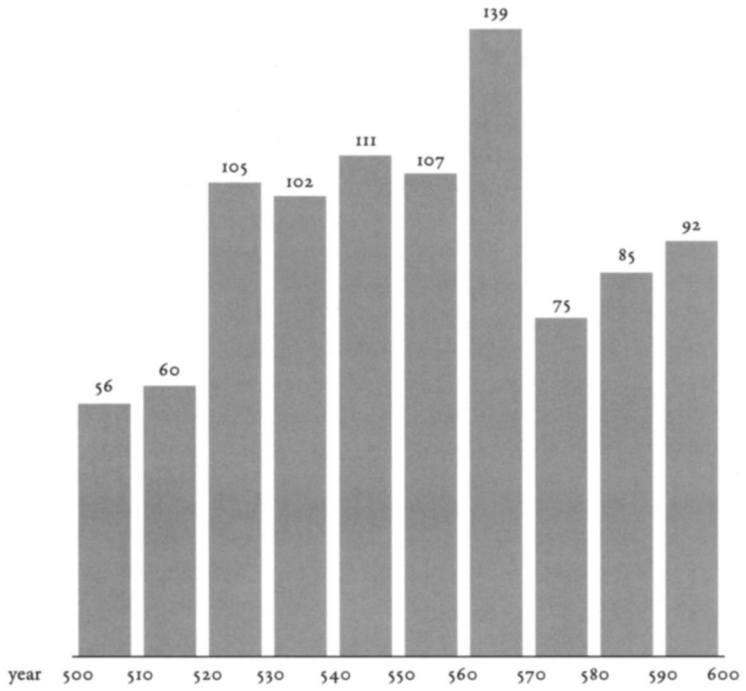


Fig. 3 Datable papyrus documents from Egypt in the sixth century by decade (graph by K. Arjava and M. Reynolds)

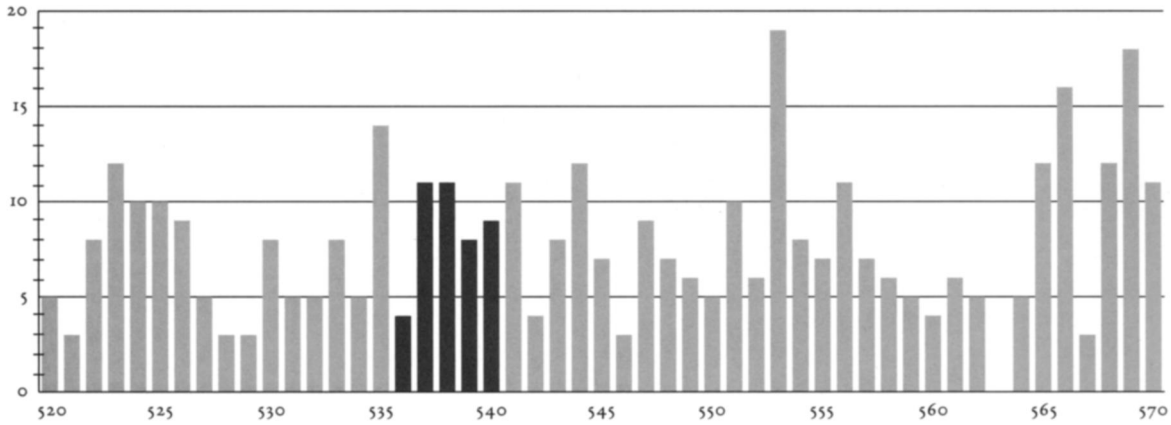
administration may be in a state of chaos. This was assumed by Duncan-Jones in his study on the effects of the Antonine plague in the second century, although the claim is not supported by comparative evidence.[88] On the other hand, failing crops and economic distress may create more documents than normal. Tax arrears and overdue loans may be recorded, new loans taken, special contracts made, and the conditions of old long-term contracts may be modified. Instead of one ten-year lease, people may prefer ten one-year leases. It has been suspected that, because of a low flood, there was an unusually large number of leases in the years 45–46 in the Tebtynis *grapheion*.[89] As evidenced by the graphs, however, the number of papyri surviving from the sixth century remains fairly constant in the middle of the century (fig. 3). Naturally, the distribution year by year varies more. The drop in 536 seemed conspicuous at first sight, especially as the next "bad year" in 542 might be connected with the plague (fig. 4), but it soon transpired that there were similar troughs elsewhere in a haphazard manner. This approach clearly does not lead us anywhere, so we can safely omit the discussion of pure numbers.[90]

88 "Antonine Plague," 108, 124–25; Greenberg, "Plagued by Doubt," 415–16 (both n. 7 above), points out that no such trend can be seen in British documents in the time of the Black Death.

89 Cf. J. Rowlandson, "Agricultural Tenancy and Village Society in Roman Egypt," in *Agriculture in Egypt from Pharaonic to Modern Times,* ed. A. K. Bowman and E. Rogan, Proceedings of the British Academy 96 (Oxford, 1999), 149.

90 The graphs in figs. 3 and 4 are based on the Heidelberg Database (*Heidelberger Gesamtverzeichnis der griechischen Papyrusurkunden Ägyptens*, online at http://www.rzuser.uni-heidelberg.de/~gV0/gvz.html, accessed September 2006). Later versions and recent papyrological publications have been consulted for relevant information, but the new papyri and improved datings would have affected the graphs only marginally. Such cases, a small percentage of the ca. 380 documents dated with sufficient precision to 521–60, have been taken into account in the discussion and in tables 1–2. The papyri are cited according to the *Checklist of Editions of Greek, Latin, Demotic and Coptic Papyri, Ostraca and Tablets*, ed. J. F. Oates et al., *BASP* Suppl. 9 (Oakville, Conn., 2001), http://scriptorium.lib.duke.edu/papyrus/texts/clist.html, accessed May 2004.

Fig. 4 Datable papyrus documents from Egypt in the sixth century by year (graph by K. Arjava and M. Reynolds)



Unfortunately, there is very little else to report. Even if the material amounts to about four hundred documents, the sample is too small to reveal any reliable statistics.[91] We cannot compare the price level, or wage level, over these decades, nor does the level of rents give any better results. As a rule, the lease contracts stipulate the amount of rent, though it is not always preserved in the surviving part of the document. However, the area of land leased was left unspecified in many contracts. This vital information consequently survives in a still smaller number of documents, thus making comparisons between the terms of different agreements difficult. In 537 we happen to have two contracts with the relevant facts: in the first one, the rent is only two *artabae* per *aroura*, a very low rent that would hardly even cover the taxes, while in the second one it is more than twice as much, five *artabae* per *aroura*, a fairly normal rent.[92] The variation in the quality of land and other circumstances is clearly enough to conceal any possible changes in the average rents over the course of time.

The length of leases merits some attention. Duncan-Jones found that, after the Antonine plague, the shortest leases (one to three years) disappeared from the record for two decades.[93] In 536 there is no change like this: everything from one to five years and more appears both before and after that date (table 1). However, if we divide the material in 541/42, to take account of the Justinianic plague, a different picture emerges (fig. 5). After twenty short-term leases between 521 and 541, there is not a single securely dated one between 542 and 550, before there are again five between 551 and 560.[94] This might suggest that the plague had some effect on either recording practice or the organization of agriculture. However, the connection must be considered tentative at best, especially as there are many leases of unknown length from those years. In the 520s, the majority of leases derive from the well-known archive of Dioskoros from the village of Aphrodito, while the Aphrodito leases constitute around one-

91 Cf. Scheidel, "Model of Change," with Bagnall, "Effects of Plague," for the Antonine plague (both n. 7 above).

92 *P. Ross. Georg.* III 36; *P. Grenf.* I 56, cf. *Berichtigungsliste* I 83. Both leases are for five years; in the first lease, the rent is the same for all years irrespective of the height of the flood, whereas in the second one, the rent is halved for individual years if the flood does not reach the fields in question. Stipulations for lower rents if the plot remains uninundated (ἄβροχος) emerge just before 536: *P. Michael.* 43 (526), *P. Strasb.* V 472 (533), *P. Lond.* V 1841 (536), *P. Grenf.* 56 (537), *P. Strasb.* VI 598 (541), V 482 (542), *SB* XIV 12052 (545), *P. Lond.* V 1770 (547), *PSI* IV 283 (550), *SB* XIV 12131 (553), XVIII 13587 (555). One possible earlier case, *P. Münch.* III 91, has been dated to the 5th century on the basis of parallels of its document type (ὑπόμνημα); but there is nothing in the contents or handwriting to exclude a dating to the 6th century (see intro. to *P. Münch.* 91, confirmed by Dieter Hagedorn in an e-mail). On the other hand, an opposite clause, to agree explicitly on a fixed rent, without regard to the flood, already appears in lease contracts in the 5th century.

93 "Antonine Plague," 122–23, criticized by Greenberg, "Plagued by Doubt," 419–21 (both n. 7 above), for failure to notice similar "deviant" periods at other times. Cf. J. Rowlandson, *Landowners and Tenants in Roman Egypt: The Social Relations of Agriculture in the Oxyrhynchite Nome* (Oxford, 1996), 252–59; and for the 6th century, J. Banaji, *Agrarian Change in Late Antiquity: Gold, Labour, and Aristocratic Dominance* (Oxford, 2001), 206; Sarris, "Justinianic Plague," 178.

94 *P. Cair. Masp.* II 67235 is dated 544/45 in the Heidelberg Database, but there do not appear any strong reasons for preferring that date to 529/30 of the previous indiction cycle; cf. H. Comfort, "Prolegomena to a Study of Late Byzantine Land-Leases," *Aegyptus* 13 (1933): 598–99 n. 2; D. Bonneau, "L'administration de l'irrigation dans les grands domaines en Égypte au VI siècle de n.è.," *Proceedings of the Twelfth International Congress of Papyrology*, American Studies in Papyrology 7 (Toronto, 1970), 49 n. 34. From 547 to 549 four documents have been drafted as liabilities to pay the rent for a land lease, *P. Cair. Masp.* I 67116, II 67128, 67129, 67251; see J. Herrmann, *Studien zur Bodenpacht im Recht der graeco-aegyptischen Papyri*, Münchener Beiträge zur Papyrusforschung und antiken Rechtsgeschichte 41 (Munich, 1958), 138. Although they concern only one year's rents, the precise arrangements of the leases are unclear: they are classed in table 1 and fig. 5 as leases of unknown length. The landlord in all of them is Dioskoros of Aphrodito, and two of them are flax leases; cf. Rowlandson, *Landowners and Tenants*, 256.

Table 1 Leases of Arable Land 521–60 CE, by Duration

	521–25	526–30	531–35	536–40	541–45	546–50	551–55	556–60
leases of 1–3 years	7	3	5	4	1	—	4	1
leases of 4–10 years	1	4	1	2	2	3	2	1
leases of undetermined length	—	1	1	1	—	3	3	—
leases of unknown length	4	2	1	1	3	7	2	1
Total	12	10	8	8	6	13	11	3

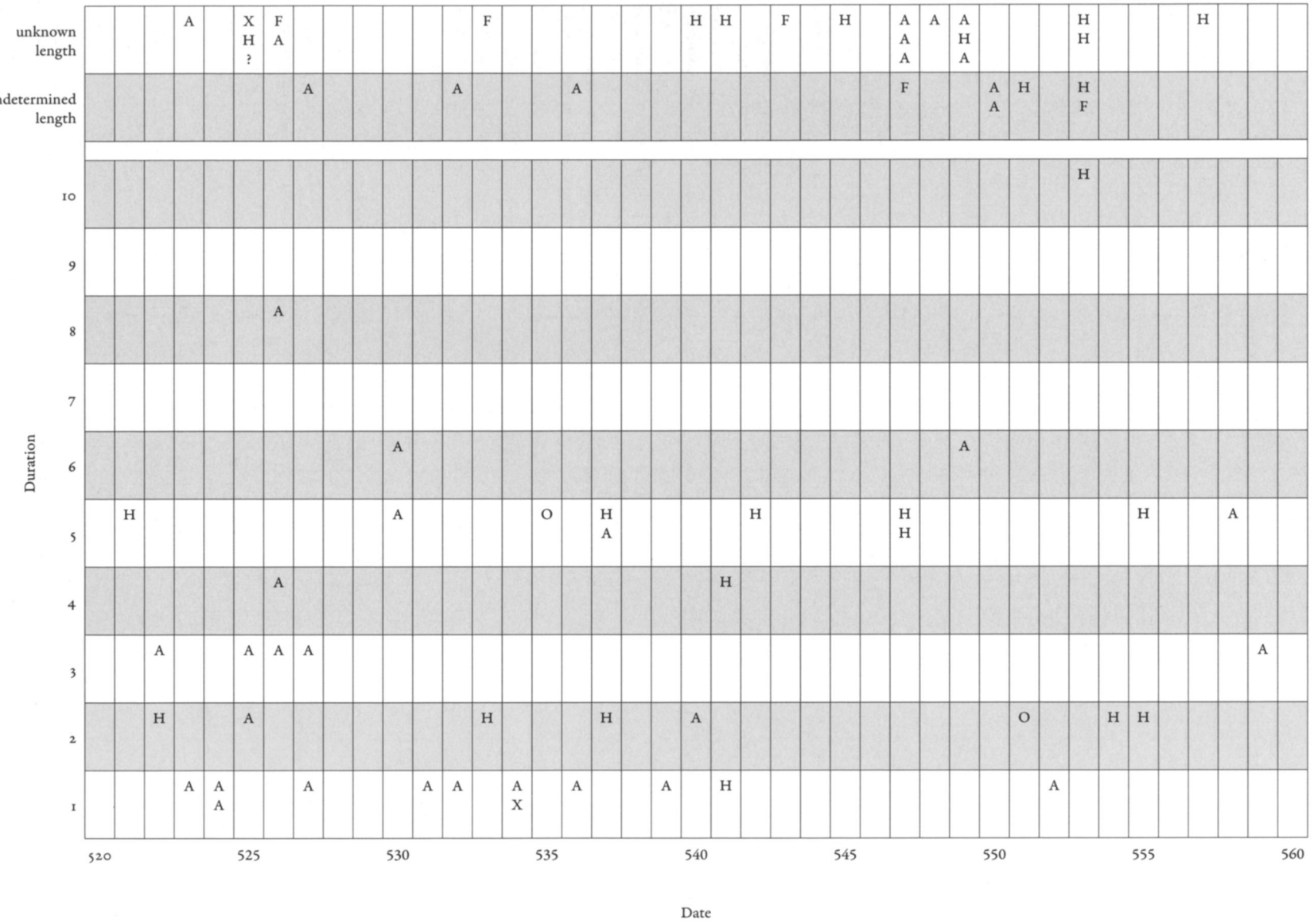

unknown length
undetermined length
Duration
10
9
8
7
6
5
4
3
2
1
520
525
530
535
540
545
550
555
560
Date

Table 2 Document Types 521–60 CE

	521–35	536–48	549–60
all datable papyri	135	136	106
documents connected with loans	19	18	14
receipts for agricultural rents	2	11	3
tax receipts	10	2	7

half of the surviving material in the following two decades; in the 550s, however, most leases come from the Hermopolite nome. There is no corresponding trend in the provenance of all papyri during this period, but even if the distribution of leases is not purely accidental, it does not seem to explain the above statistics in any significant way.

The number of documents connected with loans remains fairly constant during the same period (table 2). There are more receipts for agricultural rents from 536 to 548 than before or after that period, and fewer receipts for taxes. The reasons behind these shifts are not obvious, nor can a connection with some aberrant financial circumstances be excluded. However, I would not put too much weight on any of these statistics. Of the eleven receipts for rents between 536 and 548, no less than eight derive from the village of Aphrodito, most of them from the family of Dioskoros. Of the tax receipts, seven come from 523 to 529, none from 530 to 534, three from 535, none from 536 to 543 and two from 544. This suggests sporadic occurrence but no particular change around 536. Of course, developments in documentary practice would have been inevitable over the course of time anyway, for various reasons that we cannot hope ever to recover. It is also clear that, if we did not have independent information that something happened around this time, the changes would attract little attention. An alternative division of the material at the time of the plague in 541/42 does not seem to produce any more convincing results.

One individual, potentially significant case is a document from 538 in which a seller agrees to compensate the buyer for loss because the wine from the recent harvest had been sour.[95] This brings to mind the Syriac chronicler's report that, during the darkness, grapes had tasted sour—perhaps just a coincidence, perhaps not.

95 *P. Oxy.* XVI 1974.

Documentary evidence from outside Egypt is, of course, sparse. As it happens, the carbonized papyrus archive from Petra in Palestine includes several documents from the crucial years. There can be no doubt that a dark cloud and drought would be detrimental to agriculture in Palestine and Arabia. Among the many documents that cast light on late Roman taxation in Palestine, the Petra papyri contain three requests for transfer of taxation, so-called ἐπιστάλματα τοῦ σωματισμοῦ, from the year 538.[96] It seems that one person, Patrikios, is taking on the tax burden of another, Panolbios, for the latter's lifetime. After Panolbios's death, the land and the tax burden were to return to his heirs. Most details in these arrangements remain unknown, but it is tempting to assume that Panolbios wanted to get rid of his estates because he could not cope with his taxes. Indeed it turns out that he had not paid his taxes for several years—namely the 10th, 11th, 12th, 15th, and 1st indiction years. He had, however, already paid them for the 13th and 14th years. That would point to the 15th indiction as the first year of trouble after two better years. Whether it means the harvest of 536 or 537 is not certain because we do not know when and in what kind of installments the taxes had to be paid in Palestine. If grain taxes were paid in kind right after the harvest at the end of the indiction year,

96 J. Frösén, A. Arjava, and M. Lehtinen, eds., *The Petra Papyri I*, American Center of Oriental Research Publications 4 (Amman, 2002), documents 3–5.

Fig. 5 The duration of Egyptian arable leases, 521–60 CE. A = Antaiopolites (mainly Aphrodito), F = Fayum, H = Hermopolites, O = Oxyrhynchos, X = other areas (graph by V. Vahtikari and M. Reynolds)

the most natural assumption, then the first problem year for this taxpayer was only 537. But, as the same document reveals, tax arrears existed in Petra before that date, and other documents attest them also several decades later.[97] Thus, rather than supporting the view of an exceptional crisis after 536, this evidence suggests that difficulty of meeting tax payments was a recurring phenomenon. Note that no overdue taxes appear in the Egyptian material between 521–60.

97 E.g., *P. Petra* I 7–10.

Conclusions

Archaeological and inscriptional evidence does not help us assess the consequences of possible crop failures around 536. Recent archaeological work stresses the need for a regional approach: economic and demographic developments may differ in neighboring regions. An up-to-date synthesis is lacking for many areas. The Persian devastations in northern Syria, combined with recurrent earthquakes and epidemics, would probably explain any economic decline in that region. However, there is no way to rule out a contemporaneous climatic downturn.

Papyrological evidence is more precisely dated, permitting us to follow developments by year and month. There is a remote possibility that some observations in the papyri might be linked with the events of 536/37, but the traces are so faint that we would be justified in denying any mark of the mystery cloud in our documentation. The situation does not change much if we accept the evidence from tree rings (not confirmed by any literary source), that the coldest years occurred actually around 540. Still the papyri cannot prove that the dark cloud had only minor effects in the Byzantine empire (though it is possible). Another possibility is that Egypt was not affected by the event, while other areas were, either because the cloud did not spread below 35 degrees northern latitude or for some other reason. If the flood did not fail, then the breadbasket of the empire would have been saved from the problems that appeared in more arid regions of the Mediterranean. A third alternative is that Egypt indeed was affected but not disastrously. That is, the everlasting instability of the Nile had accustomed people to a situation where good and bad harvests alternated, and they had developed buffer mechanisms. This was, of course, to a great extent typical of the whole ancient world.[98] Moderate insecurity may create stronger societies.

Finally, and perhaps most important, even major calamities can pass unnoticed in the papyrological record. That is shown by the Justinianic plague, which is amply attested in other written sources but has left little trace in the papyri.[99] This fact alone should caution us against putting too much faith in a negative result. Moreover, the same caution is appropriate when assessing individual pieces of literary evidence. Even the most exhaustive source for the period, Prokopios, does not record the north Italian famine of 537, which is described by Cassiodorus and the *Liber pontificalis*, although he reports another famine just two years later. Any conclusions must be based on the cumulative evidence of all relevant authors.

Nevertheless, it is still possible to state the results of this inquiry with relative certainty. Not only is there nothing in our evidence to suggest that the year 536 was a watershed moment between antiquity and the Middle Ages, a conclusion that must have appeared obvious from the very beginning, but it is also evident that, although the cloud occasioned confusion and crop failure at the time of its appearance, its effects did not last long after it had dissipated. Compared with almost all other contemporary civilizations around the world, the circumstances in the Mediterranean area are extremely well documented.

98 See, e.g., Garnsey, *Famine and Food Supply* (n. 87 above); T. W. Gallant, *Risk and Survival in Ancient Greece: Reconstructing the Rural Domestic Economy* (Stanford, 1991).

99 The lack of any explicit reference to the Justinianic plague in the papyri was noted by G. Casanova, "Epidemie e fame nella documentazione greca d'Egitto," *Aegyptus* 64 (1984): 167–68, 177, and this is confirmed by the present study. The disappearance of short-term leases from the papyri is a possible exception. It may be noted that Byzantine authors have left few accounts of the Black Death in the 14th century, although it is known to have ravaged the country; see D. M. Nicol, *The Last Centuries of Byzantium 1261–1453*, 2nd rev. ed. (Cambridge, 1993) 216–18; M.-H. Congourdeau, "Pour une étude de la peste noire à Byzance," in *ΕΥΨΥΧΙΑ: Mélanges offerts à Hélène Ahrweiler*, Byzantina Sorbonensia 16 (Paris, 1998), 149–63. I owe this insight to Alice-Mary Talbot.

The literary sources that record the darkness of 536/37 all seem to consider it a temporary misfortune. Among the innumerable earthquakes, droughts, plagues, swarms of locusts, and slaughters that are listed by the historians of this time, the dark cloud was not considered a particularly severe catastrophe. Shortage of food was recurrent in the ancient world, and people were used to it, however intense the short-term suffering might be. Even if the eruption of Etna really caused a food crisis in Egypt and perhaps elsewhere in the Mediterranean after 44 BCE, no one would claim that Egyptian society or the Roman Empire suffered any long-term harm from it—possible short-term political implications aside. The murder of Caesar had been planned before the eruption, but if the Roman sources were as inaccurate as they are for most regions and historical periods, someone would certainly be tempted to connect the natural phenomenon with political change.

Thus the combined force of the available evidence irresistibly shows that, whatever happened around 536, its historical implications remained limited, at least in the Mediterranean area. On the other hand, the sources clearly show that a mysterious fog dimmed the sun for more than a year. Although the haze has been called a dry fog or dust veil ever since 1984, the hitherto-neglected passage from John Lydos rather suggests that the fog was damp. This is not in itself decisive because it can be reasonably claimed that Lydos may not have been able to observe its actual composition, and the ancient sources are contradictory or ambiguous about this matter. However, he also asserts that the fog was seen only in Europe, and it is more difficult to discredit this report, which contradicts the common scholarly assumption that the cloud was global or at least hemispherical. Remarkably all the other literary sources attest the fog only for an area around Italy and Asia Minor.

We cannot check the scientific accuracy of Lydos's reports. They may mislead us, but at the very least they invite us to reexamine the scientific evidence for the event. It remains true that the Greenland ice cores have so far produced little proof of volcanic activity around 536, and that the tree rings are surprisingly ambiguous about climatic variation in different parts of the world between 535 and 552. Two main alternatives emerge. The dark cloud may have originated from a northern volcano, being visible only at latitudes north of the Mediterranean, a phenomenon that Lydos erroneously interpreted as a west/east difference, or the fog may have been locally more restricted, perhaps damp, originating from a totally unknown source. Because a tropospheric fog of such duration would be exceptional, the first alternative seems at present more likely. Further ice cores may prove or disprove it in the future. However, for those who are not yet convinced by the volcano hypothesis, the second alternative might appear worth serious consideration. In sum, although I hope to have provided some insight into the historical impact of the fog, I am afraid the veil of mystery around its physical nature has not yet dissipated.

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